B.Sc. (ME) / 6th Semester

Date: 17th February 2023 (Morning)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Mid Semester Examination
Course Number: ME 4611
Course Title: Fluid Machinery

Summer Semester: 2021 – 2022
Full Marks: 75
Time: 1.5 Hours

There are **3 (Three)** questions. Answer **all** the questions. Marks of each question and corresponding COs/POs are written inside the square brackets. The symbols have their usual meanings. Assume any missing data if necessary.

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1. **(a)** Briefly explain the different types of draft tubes used in reaction turbines with neat sketches. **[10]** [CO2] [PO2]

   (b) Show that the specific speed of a Pelton Wheel is inversely proportional to the jet ratio. **[8]** [CO2] [PO2]

   (c) Describe the construction and working principle of Francis Turbine and Bulb Turbine with schematic layouts. **[12]** [CO2] [PO2]

2. **(a)** A Kaplan turbine is to be designed to develop 7.5 MW; the available net head is 6 m. The other relevant data are the following: Speed ratio = 2.05, Flow ratio = 0.66, Overall efficiency = 90%, Hydraulic efficiency = 95%, and the diameter of the hub is 1/3 the diameter of the runner. Calculate the following: **[10]** [CO3] [PO4]
   (i) the diameter of the runner.
   (ii) specific speed.
   (iii) inlet guide vane angle at the tip of the blades.
   (iv) inlet and outlet blade angle at the mid-radius.

   (b) A Pelton turbine has a net head of 425 m. Assuming $C_v = 0.97$, speed ratio $K_u = 0.46$, jet deflection angle at the bucket $\beta_2 = 165°$ and bucket friction coefficient $K = 0.9$, calculate the following: **[6]** [CO3] [PO4]
   (i) hydraulic efficiency.
   (ii) wheel efficiency.
   (iii) nozzle efficiency of the turbine.

   (c) A Pelton wheel is working under a head of 180 m with a discharge of 0.8 m^3/s. The following data are available for the turbine: Coefficient of velocity = 0.985, Angle of deflection of jet = 165°, Speed ratio = 0.46, Jet ratio = 12, *Relative velocity at exit = Relative velocity at inlet*. Compute the following: **[9]** [CO3] [PO4]
   (i) hydraulic efficiency.
   (ii) velocity of whirl at inlet and outlet.
   (iii) mean bucket speed.
   Assume zero frictional loss in the bucket.

3. **(a)** A 1/5 scale model of a Kaplan turbine is designed to operate at a head of 25 m. The prototype produces 18.5 MW of power under a head of 49 m when operating at a speed of 250 rpm. Find the speed, discharge, and power of the model. Assume the efficiency of the model and prototype is the same at a value of 88%. **[6]** [CO3] [PO4]

(b) A Francis turbine has a degree of reaction of 0.6. The peripheral velocity at the inlet is 15 m/s, and the flow velocity is constant at 3 m/s. The rotor diameter at entry is twice that at the exit. In addition, the discharge is radial. Assuming no frictional losses, determine the blade angles at entry and exit. **[8]** [CO3] [PO4]

(c) A conical draft tube of a reaction turbine has diameters of 1.5 m and 2 m at its ends. The turbine is set 7 m above the tailrace level. When the discharge from the turbine is 12 m^3/s, calculate the following: **[6]** [CO3] [PO4]
(i) pressure head at the entrance of the draft tube.
(ii) efficiency of the draft tube.
Assume energy loss in the draft tube as 0.35 times the velocity head at the draft-tube exit. Take the atmospheric pressure head as 10.3 m of water.